

**WHAT IS CLAIMED IS:**

1. A method for repairing mask damage defects, the method comprising:  
determining topographical information of a defect on a mask;  
determining one or more grating repair specifications based on an optical simulation using the topographical information; and  
forming one or more artificial grating areas on one or more sides of the defect based on the grating repair specification,  
wherein the artificial grating areas are no wider than a predetermined wavelength used for photolithography in which the mask is used, and  
wherein the artificial grating areas change the effective refractive index of a localized area encompassing the defect so that the defect does not cause undesired image printing when the mask is exposed to a light source of the predetermined wavelength.
2. The method of claim 1 wherein the determined topographical information further includes phase depth information of the defect.
3. The method of claim 1 wherein the determined topographical information further includes a width of the defect.
4. The method of claim 1 wherein determining one or more grating repair specifications further includes:  
determining a phase change to avoid the undesired image printing problem;  
and  
determining geometric specifications of the artificial grating areas based on

the determined phase change.

5. The method of claim 4 wherein the determining the phase change further includes generating aerial intensity and near field phase information for the defect.
6. The method of claim 4 wherein the determining geometric specifications of the artificial grating area further includes determining a groove depth, pitch, and grating space of the grating area.
7. The method of claim 6 wherein the determining a groove depth, pitch and grating space further includes:
  - selecting the grating space;
  - determining the groove depth;
  - determining a fill factor based on the selected grating space; and
  - determining the pitch based on the fill factor and the grating space.
8. The method of claim 4 wherein the determining geometric specifications of the artificial grating area further includes determining a width of the grating area.
9. The method of claim 1 further comprising confirming the defect is repaired by determining modified topographical information of the localized area and conducting one or more optical simulations using the modified topographical information.
10. The method of claim 1 wherein the mask is made of quartz.

11. A method for repairing defects in a mask to be used for a lithography process using a light source having a predetermined wavelength under 193 nm, the method comprising:

determining topographical information of a defect;

determining one or more grating repair specifications based on an optical simulation using the topographical information; and

forming one or more artificial grating areas on one or more sides of the defect based on the grating repair specification,

wherein the artificial grating areas are no wider than the predetermined wavelength, and

wherein the artificial grating areas change the effective refractive index of a localized area encompassing the defect so that the defect does not cause undesired image printing when the mask is exposed to the light source of the predetermined wavelength.

12. The method of claim 11 wherein the determined topographical information further includes phase depth information of the defect.

13. The method of claim 11 wherein the determined topographical information further includes a width of the defect.

14. The method of claim 11 wherein the determining one or more grating repair specifications further includes:

determining a phase change to avoid the undesired image printing problem;

and

determining geometric specifications of the artificial grating areas based on

the determined phase change.

15. The method of claim 14 wherein the determining the phase change further includes generating aerial intensity and near field phase information for the defect.

16. The method of claim 14 wherein the determining geometric specifications of the artificial grating area further includes determining a groove depth, pitch, and grating space of the grating area.

17. The method of claim 16 wherein the determining a groove depth, pitch and grating space further includes:

- selecting the grating space;

- determining the groove depth;

- determining a fill factor based on the selected grating space; and

- determining the pitch based on the fill factor and the grating space.

18. The method of claim 14 wherein the determining geometric specifications of the artificial grating area further includes determining a width of the grating area.

19. The method of claim 11 further comprising confirming the defect is repaired by determining modified topographical information of the localized area and conducting one or more optical simulations using the modified topographical information.

20. A method for repairing mask pits on a quartz mask, the method comprising:  
determining topographical information of a pit;

determining one or more grating repair specifications based on an optical simulation using the topographical information; and

forming one or more artificial grating areas on one or more sides of the pit based on the grating repair specification,

wherein the artificial grating areas are no wider than a predetermined wavelength used for photolithography in which the mask is used, and

wherein the artificial grating areas change the effective refractive index of a localized area encompassing the pit so that the pit does not cause undesired image printing when the mask is exposed to a light source of the predetermined wavelength.

21. The method of claim 20 wherein the determining one or more grating repair specifications further includes:

determining a phase change to avoid the undesired image printing problem based on aerial intensity and near field phase information for the pit; and

determining geometric specifications of the artificial grating areas based on the determined phase change.

22. The method of claim 21 wherein the determining geometric specifications of the artificial grating area further includes determining a groove depth, pitch, and grating space of the grating area.

23. The method of claim 20 further comprising confirming the pit is repaired by determining modified topographical information of the localized area and conducting one or more optical simulations using the modified topographical information.